Machine learning (ML) in finance: Lessons learned

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Workshop on Credit Card Lending and Payments

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What is new and what is old?

Professor John McCarthy - Stanford University ~1967

Image source: twitter.com/computertales/status/912177367702843392

Why so much excitement about ML now?

COCOQA 5078
How many leftover donuts is
the red bicycle holding?
Ground truth: three

Deep learning (DL)

- DL has enabled a Kuhnian wave of scientific progress.

- Especially in vision and in combined language/vision.

- DL yields higher accuracy in many applications, such as forecasting.

Image source: http://www.cs.toronto.edu/~mren/imageqa/

What can we do now that we couldn't do before?
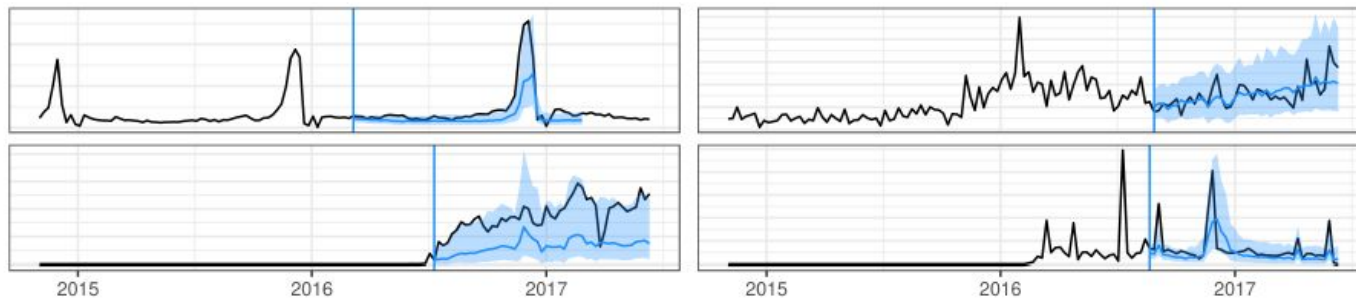
Figure 3: MQ-RNN Forecasts for four example products.

Source: https://arxiv.org/pdf/1711.11053.pdf
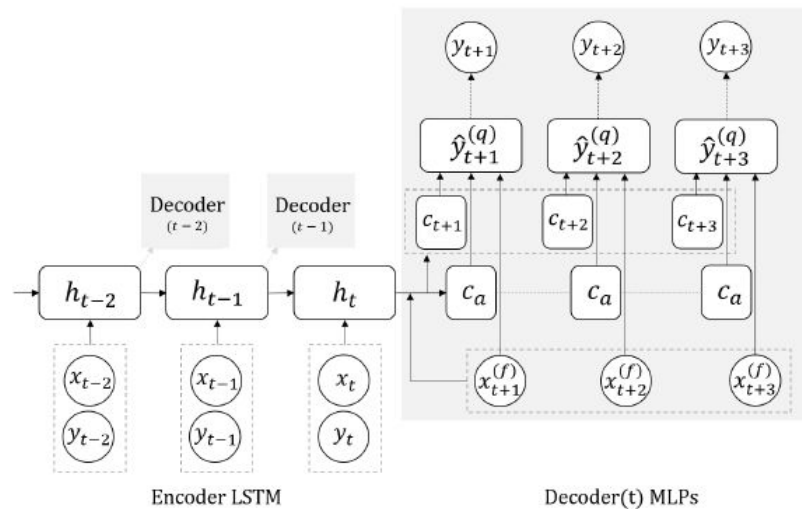
Deep understanding

Is the answer really three? Maybe it is three and a half? Or three and two pieces?

Deep understanding combines language *and* vision *and* knowledge *and* personal experience.

In this example, deep understanding requires reasoning about occlusion, about gravity, about social conventions, and more.

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Is deep understanding really needed?

Yes, for "AI-complete" tasks.

Example: True autonomous driving is AI-complete.

■ To be fully self-driving, a car needs to understand symbolic human gestures.

Source: https://www.express.co.uk/news/nature/665681/man-stops-traffic-duck-ducklings-cross-road-animal-lover-John-Ridley-Cheltenham

In finance, what is different about ML?

ML methods are continuous with other quantitative methods. So what is different?

- One answer: ML is fundamentally empirical, while other methods are deductive.

Example: Black-Scholes provides the unique rational price for an option, given some assumptions.

But empirically, Black-Scholes prices are not valid!
So there are opportunities to apply ML.

Implied volatility surface
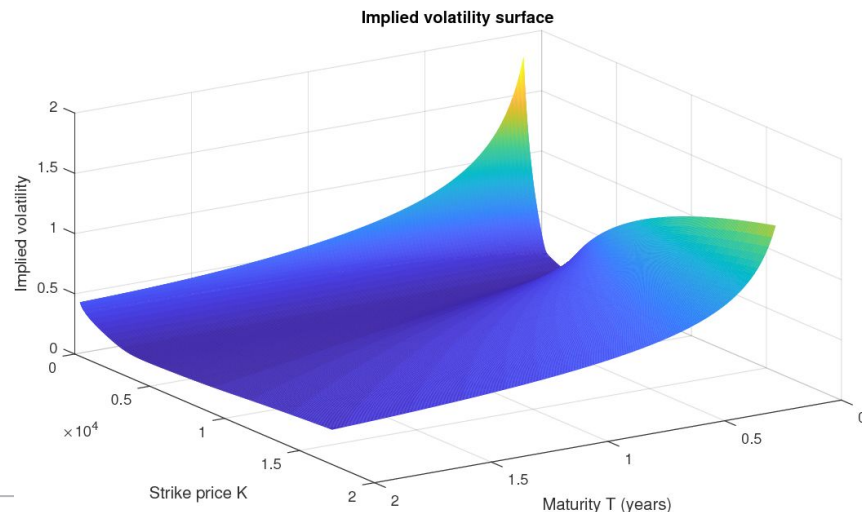
What is the same about ML in finance?

Management of model risk is not fundamentally different:

- All models are only approximately correct.
- All models can fail badly when something in the environment changes.

Embrace knowledge, such as pricing relative to a yield curve.

Embrace deduction, such as computing "yield to worst."

Understand the limitations of existing knowledge and methods.

Use ML to overcome these.

FUNDAMENTALS
The Fundamentals Improve

REFLEXIVITY

PRICE
Price Increases

PERCEPTION
Investors Perceptions/Expectations Adjust Higher
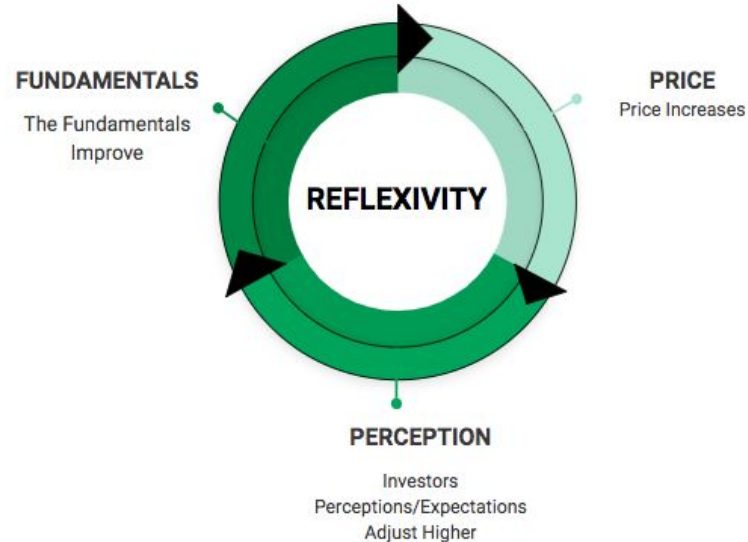
Finding good applications for ML

Identifying an application is a conversation between business experts and technical experts.

Look for an opportunity to automate decision-making, such as purchasing.

- Making real-time automatic decisions is more useful than one-off analysis, or reporting.

1. Start by identifying the decisions that need to be made.
2. Work backwards to the predictions that would help make better decisions.
3. Work backwards to the historical data needed to learn to make these predictions.

ML is used to estimate relevant information that is otherwise not available.

Fitting ML into an existing workflow

The full workflow for a business application can rarely be 100% based on ML.

Example: If we have an automated system for trading bonds, pause the automation when there is news about an issuer, and/or a jump in the price of the corresponding equity.

Most ML applications improve an existing workflow, and do not change it fundamentally.

A corollary: ML cannot rescue a bad business model.

Workflow principles

Common principle:

- Predictions should be real-time, so they can be based on the newest available data.
- Training should be off-line, because putting a new model into production carries risk.

Aim for orthogonality: Use ML to improve one aspect of the business process, without changing others.

Example: Using ML to drive more loan applications is orthogonal to credit approval for the applicants.

But are applications and approval really orthogonal?

Understanding the true business process

Example: Consider probability of default (PD and loss given default (LGD). Loans that may default are restructured, and not recorded as defaults. So are we missing data about *true* economic losses?

New Terms for Trump From Big Bank Lenders

By RICHARD D. HYLTON   JUNE 20, 1990

Donald J. Trump's four leading bank lenders worked out a tentative agreement yesterday to lend the developer $65 million and defer interest and principal payments on about $850 million of the developer's nearly $2 billion of debt, people involved in the talks said. But the banks must now persuade other lenders to go along, and several hurdles remain to be cleared with Mr. Trump himself.

Risks for an ML application

1. Lack of consensus on a relevant quantitative objective.

2. Too few decisions to be made, each one too important. Example: Venture capital investments.

3. Outputs are not accurate enough to be useful. Example: Understanding legal language.

4. Real-time data and/or historical data are different, and/or not available.

5. The model is not explainable enough for stakeholders to feel comfortable.

6. The ML method is held to a higher standard than ~~humans, or than the~~ current business process.

Summary: The promise and the peril

Do use the latest AI methods to discover patterns in data

- Analyze multiple types of data simultaneously

- Expect super-human performance in some ways, but not in deep understanding

- Look for systems that use the complementary strengths of software and of humans

Do not expect genuine artificial intelligence in the foreseeable future

- But don't be confident that genuine AI is impossible

- We can't predict when, but there will be more breakthroughs in research in the future

- Speculating about super-intelligence is like speculating about life on other planets

Thank you

Questions welcome!